A systematic approach to optimize parameters in manufacturing complex lattice structures of NiTi using electron beam PBF process

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Abstract:

In this study, the quality and accuracy to manufacture delicate parts from NiTi powder using electron beam powder bed fusion (EB-PBF) technology is investigated. Therefore, benchmarks with thin cylinders and thin walls were designed and fabricated using two distinct scan strategies of EB-PBF manufacturing (i.e., continuous melting and spot melting) with different process parameter sets. After these optimizations, four different lattice structures (i.e., octahedron, cell gyroid, sheet gyroid and channel) were manufactured and characterized. It is shown both continuous melting and spot melting modes are able to manufacture lattices with relative densities over 97%. And, as-built lattice structures exhibit an excellent spring-back up to 8% depending on the design of the structure, e.g., the channel structure shows more deformation recoverability than the cell gyroid. This is attributed to the integrity of geometry as well as compressive mode of the mechanical loading. Of course, the compressive strength and ultimate compressive strength also increases with increasing the volume fraction. Moreover, the spot melting could be used as an engineering tool to customize a delicate beam-shaped structure with a superior pseudoelasticity.

Keywords:

EB-PBF, Continuous melting, Spot melting, NiTi, Pseudoelasticity